<u>I. Amendments to the Claims</u>

This listing of claims will replace without prejudice all prior versions and listing of claims in the application:

<u>Listing of Claims</u>:

Claims 1 to 31 Cancelled

32. (New) A method of registering a needle in a patient target volume in an ultrasound imaging system, comprising:

capturing a first ultrasound image of the patient target volume using an ultrasound probe prior to insertion of the needle into said patient target volume;

capturing a second ultrasound image of a sub-sector of said patient target volume using the ultrasound probe after insertion of the needle into said patient target volume, said sub-sector corresponding generally to a predicted trajectory of the needle within said patient target volume;

computing the actual trajectory of said needle in said patient target volume using a computing device, differences detected between said first and second ultrasound images; and

with the actual needle trajectory computed, computing at least one of a needle tip location and an entry location of the needle into said patient target volume.

33. (New) The method of claim 32 comprising computing both the needle tip location and the needle entry location.

34. (New) The method of claim 33 wherein said actual needle trajectory computing comprises:

generating a difference map from said first and second ultrasound images; and

examining said difference map to determine voxels representing the needle.

35. (New) The method of claim 34 wherein said difference map generating comprises:

comparing each pair of corresponding voxels of said first and second ultrasound images to determine a resultant difference voxel for each pair;

examining each difference voxel to determine if its magnitude exceeds a threshold; and

populating the difference map with difference voxels having magnitudes exceeding the threshold.

36. (New) The method of claim 35 further comprising filtering the difference map to remove voxels deemed to be noise.

37. (New) The method of claim 36 wherein said filtering comprises:

examining voxels of said difference map to detect voxels that are more than a threshold distance from the predicted needle trajectory; and

removing the detected voxels from said difference map.

38. (New) The method of claim 37 wherein said actual needle trajectory computing further comprises:

fitting a line to the voxels in said difference map; and

using the equation of the line to represent said actual needle trajectory.

39. (New) The method of claim 38 wherein said line is fitted to the voxels using linear regression analysis.

40. (New) The method of claim 38 wherein said actual needle trajectory computing further comprises removing voxels in said difference map that are beyond a threshold distance from the predicted needle trajectory.

41. (New) The method of claim 40 wherein said needle tip location computing comprises determining the voxel in said difference map that is positioned furthest along said actual needle trajectory.

42. (New) The method of claim 41 wherein said needle entry location computing comprises calculating the intersection of the actual needle trajectory with a known needle patient target volume entry plane.

43. (New) The method of claim 42 further comprising generating an ultrasound image of a plane within said patient target volume including said needle.

44. (New) The method of claim 43 wherein said ultrasound image generating comprises:

capturing a third ultrasound image of the patient target volume using the ultrasound probe;

selecting an arbitrary point in said third ultrasound image;

defining a plane coplanar with the needle using the needle tip location, the needle entry location and the arbitrary point; and

extracting ultrasound image data along said plane to generate the ultrasound image of said plane.

45. (New) The method of claim 44 wherein selecting the arbitrary point to be on a line intersecting the needle entry location and parallel to a y-axis, defines a sagital-oblique plane and wherein selecting the arbitrary point to be on a line intersecting the needle entry location and parallel to an x-axis defines a coronal oblique plane.

46. (New) The method of claim 34 wherein said actual needle trajectory computing further comprises:

fitting a line to the voxels in said difference map; and

using the equation of the line to represent said actual needle trajectory.

47. (New) The method of claim 46 wherein said line is fitted to the voxels using linear regression analysis.

48. (New) The method of claim 47 wherein said actual needle trajectory computing further comprises removing voxels in said difference map that are beyond a threshold distance from the predicted needle trajectory.

49. (New) The method of claim 48 wherein said needle tip location computing comprises determining the voxel in said difference map that is positioned furthest along said actual needle trajectory.

50. (New) The method of claim 49 wherein said needle entry location computing comprises calculating the intersection of the actual needle trajectory with a known needle patient target volume entry plane.

51. (New) The method of claim 50 further comprising generating an ultrasound image of a plane within said patient target volume including said needle.

52. (New) The method of claim 51 wherein said ultrasound image generating comprises:

capturing a third ultrasound image of the patient target volume using the ultrasound probe;

selecting an arbitrary point in said third ultrasound image;

defining a plane coplanar with the needle using the needle tip location, the needle entry location and the arbitrary point; and

extracting ultrasound image data along said plane to generate the ultrasound image of said plane.

53. (New) The method of claim 52 wherein selecting the arbitrary point to be on a line intersecting the needle entry location and parallel to a y-axis, defines a sagital-oblique plane and wherein selecting the arbitrary point to be on a line intersecting the needle entry location and parallel to an x-axis defines a coronal oblique plane.

54. (New) A method, comprising:

imaging a patient target volume using an elongate ultraound probe and generating a three-dimensional ultrasound image of said patient target volume;

inserting a needle into said patient target volume using a needle driving apparatus;

imaging a sub-sector of said patient target volume using said elongate ultraound probe and generating a three-dimensional ultrasound image of said patient target volume sub-sector, said patient target volume sub-sector encompassing a predicted trajectory of the needle within said patient target volume;

computing the actual trajectory of said needle in said patient target volume using a computing device based on differences detected between the patient target volume three-dimensional ultrasound image and the patient target volume sub-sector three-dimensional ultrasound image; and

with the actual needle trajectory computed, computing a needle tip location and an entry location of the needle into said patient target volume.

55. (New) The method of claim 54 further comprising:

mapping a coordinate system of said elongate ultrasound probe to a coordinate system of said needle driving apparatus; and

using needle position information from said needle driving apparatus to determine said predicted needle trajectory.

56. (New) The method of claim 55 wherein said actual needle trajectory computing comprises:

generating a difference map from said patient target volume and patient target volume sub-sector ultrasound images; and

examining said difference map to determine voxels representing the needle.

57. (New) The method of claim 56 wherein said difference map generating comprises:

comparing each pair of corresponding voxels of said patient target volume and patient target volume sub-sector ultrasound images to determine a resultant difference voxel for each pair;

examining each difference voxel to determine if its magnitude exceeds a threshold; and

populating the difference map with difference voxels having magnitudes exceeding the threshold.

58. (New) The method of claim 57 further comprising filtering the difference map to remove voxels deemed to be noise.

59. (New) The method of claim 58 wherein said filtering comprises:

examining voxels of said difference map to detect voxels that are more than a threshold distance from the predicted needle trajectory; and

removing the detected voxels from said difference map.

60. (New) The method of claim 59 wherein said actual needle trajectory computing further comprises:

fitting a line to the voxels in said difference map; and

using the equation of the line to represent said actual needle trajectory.

61. (New) The method of claim 60 wherein said line is fitted to the voxels using linear regression analysis.

62. (New) The method of claim 60 wherein said actual needle trajectory computing further comprises removing voxels in said difference map that are beyond a threshold distance from the predicted needle trajectory.

63. (New) The method of claim 62 wherein said needle tip location computing comprises determining the voxel in said difference map that is positioned furthest along said actual needle trajectory.

64. (New) The method of claim 63 wherein said needle entry location computing comprises calculating the intersection of the actual needle trajectory with a known needle patient target volume entry plane.

65. (New) The method of claim 63 further comprising generating an ultrasound image of a plane within said patient target volume including said needle.

66. (New) The method of claim 65 wherein said ultrasound image generating comprises:

capturing a third ultrasound image of the patient target volume using said elongate ultrasound probe;

selecting an arbitrary point in said third ultrasound image;

defining a plane coplanar with the needle using the needle tip location, the needle entry location and the arbitrary point; and

extracting ultrasound image data along said plane to generate an ultrasound image of said plane.

67. (New) The method of claim 60 further comprising generating an ultrasound image of a plane within said patient target volume including said needle.

68. (New) The method of claim 67 wherein said ultrasound image generating comprises:

capturing a third ultrasound image of the patient target volume using said elongate ultrasound probe;

selecting an arbitrary point in said third ultrasound image;

defining a plane coplanar with the needle using the needle tip location, the needle entry location and the arbitrary point; and

extracting ultrasound image data along said plane to generate an ultrasound image of said plane.

69. (New) A system, comprising:

an ultrasound transducer imaging a patient target volume prior to insertion of a needle in said patient target volume and imaging a sub-sector of said patient target volume after insertion of the needle in said patient target volume, said patient target volume sub-sector encompassing a predicted trajectory of the needle within said patient target volume;

a needle driving apparatus for inserting a needle into said patient target volume; and

a processor communicating with said ultrasound transducer and said needle driving apparatus, said processor computing the actual trajectory of said needle in said patient target volume using differences detected between the imaged patient target volume and the imaged patient target volume sub-sector and with the actual needle trajectory computed, said processor computing a needle tip location and an entry location of the needle into said patient target volume.

70. (New) The system of claim 69 wherein said processor maps a coordinate system of said ultrasound transducer to a coordinate system of said needle driving apparatus and uses needle position information from said needle driving apparatus to determine said predicted needle trajectory.

71. (New) The system of claim 70 wherein during actual needle trajectory computing, said processor generates a difference map from said imaged patient target volume and said imaged patient target volume sub-sector and examines said difference map to determine voxels representing the needle.

72. (New) The system of claim 71 wherein during difference map generating, said processor compares each pair of corresponding voxels of said imaged patient target volume and said imaged patient target volume sub-sector to determine a resultant difference voxel for each pair,

examines each difference voxel to determine if its magnitude exceeds a threshold and populates the difference map with difference voxels having magnitudes exceeding the threshold.

73. (New) The system of claim 72 wherein said processor filters the difference map to remove voxels deemed to be noise.

74. (New) The system of claim 71 wherein during actual needle trajectory computing, said processor fits a line to the voxels in said difference map and uses the equation of the line to represent said actual needle trajectory.

75. (New) The system of claim 74 wherein during needle tip location computing, said processor determines the voxel in said difference map that is positioned furthest along said actual needle trajectory.

76. (New) The method of claim 75 wherein during needle entry location computing, said processor calculates the intersection of the actual needle trajectory with a known needle patient target volume entry plane.

77. (New) The method of claim 74 wherein said processor generates an ultrasound image of a plane within said patient target volume including said needle.

78. (New) The method of claim 77 wherein during ultrasound image generating, said processor captures a third ultrasound image of the patient target volume, selects an arbitrary point in said third ultrasound image, defines a plane coplanar with the needle using the needle tip location, the needle entry location and the arbitrary point and extracts ultrasound image data along said plane to generate an ultrasound image of said plane.